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Observations of Manatees in Aggregations¹

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During the years from 1949 to 1955 as park biologist in the Everglades National Park, Florida, I was greatly attracted by the mystery surrounding the life and habits of the manatee, *Trichechus manatus latirostris*, living there. However, the manatee habit of living beneath turbid waters in remote inland bays and labyrinthine waterways of the vast mangrove area, together with the retiring manner of exposing only the snout at the surface to breathe briefly at intervals of 10 minutes or so, makes the animal in the wild a difficult one to observe. This pattern of secretive behavior was surely sustained by their persecution, before the area became a national park, by meat-hungry commercial fishermen who hunted them illegally. Even before the white fishermen came, the local Indians were known to have preyed upon them for their flesh. Harlan (1824, p. 392) wrote, "They are found in considerable numbers about the mouths of rivers, near the capes of east Florida, lat. 25° [south end of Key Biscayne in the Miami area]. The Indians kill them with the harpoon, during the summer months. One Indian has been enabled to capture ten or twelve during a season." This sort of persecution seems to have prevailed elsewhere in manatee range, perhaps ever since primitive man was first able to devise successful means for taking the manatee. Humboldt (1852, p. 170) reported the flesh of the fresh-water manatee, *Trichechus inunguis*, to be "esteemed by the Guamos and the Ottomacs; and these two nations [at the headwaters of the Amazon and Orinoco rivers in South America] are particularly expert in catching the Man-

¹ Parts of this paper were read before the American Society of Mammalogists in June, 1956; and the whole paper constitutes an expansion of the presidential address of the Florida Academy of Sciences for 1955.

atee." Baughman (1946) cites other such accounts relating to Brazil, Honduras, and Guiana. If this persecution has produced the same secretive habits in manatees throughout their range, it may well explain why reported observations on the behavior of free, wild ones anywhere are exceedingly scarce.

The following account provides a quantitative indication of the difficulty of obtaining observations of manatees in their native habitat by ordinary means. My field notes, recorded during six and a half years, reveal 5028 nautical miles traveled by boat in waters of the Everglades National Park where manatees could occur. During this ordinarily alert, watchful travel manatees were encountered only 13 times; thus one encounter occurred for each 386 miles. It is true, however, on the basis of my own experience, and study of the observations recorded by patrolling rangers, that the inland waters of the west coast of the park is the area in which the manatees primarily occur. In this more proper manatee habitat, then, my field notes show 975 miles of boat travel for 13 encounters with manatees. The rate thus restricted is still no better than 75 miles per encounter. Such poor return of manatee information results in part from use of conventional motor boats and in part from subordination of manatee study to that of other segments of the fauna. With more specialized equipment and focus of effort, and as manatees multiply and become less fearful under ranger protection, better results should be obtained.

It seemed to be general knowledge among south Florida naturalists that manatees could be seen rather frequently in the Miami River within the city of Miami, particularly from bridges. Bridge-rail fishermen and bridge tenders told me that the best time and place to see manatees was on a cold morning at the Miami Avenue bridge. Trying this, I soon found that whenever the temperature dropped several degrees below 50° F. during the night, and I was able to be there to observe the next morning, manatees were congregated in the Miami River beneath the Miami Avenue bridge near the north bank. An outflow of warm water from a near-by power plant enters the river from a 6-by-6 foot outlet under the bridge, and the sea cows loiter in this warm current. During the winter of 1949-1950 I watched them rising to breathe here in the turbid waters of the river on 11 different days.

One of the first things discovered about the manatees in these aggregations was that some of them were distinctively marked. They displayed prominent scars, great notches in their tails, and distinctive arrangements of lesser scars and notches. Many of these wounds had been inflicted in series, quite evidently by whirling propellers of boats. Some

others, showing as long straight marks scraped white on the surface of the back, appeared to be keel marks of boats. Figure 1 shows several marked manatees. I began a numbered file of individually identifiable manatees with drawings of their identifying marks. Each of these was painstakingly sketched into a stenciled outline of a manatee form while the animal was in sight, and a record was kept on it of the occasions on which each was subsequently identified.

The value that repeated observations of marked manatees might have over a period of years was apparent to me, but repetition of such a strange opportunity year after year seemed too improbable to depend on, and during that first season the primary effort went into recording observations, realization of the values of which did not depend on repetition in future years. These have been published (Moore, 1951a).

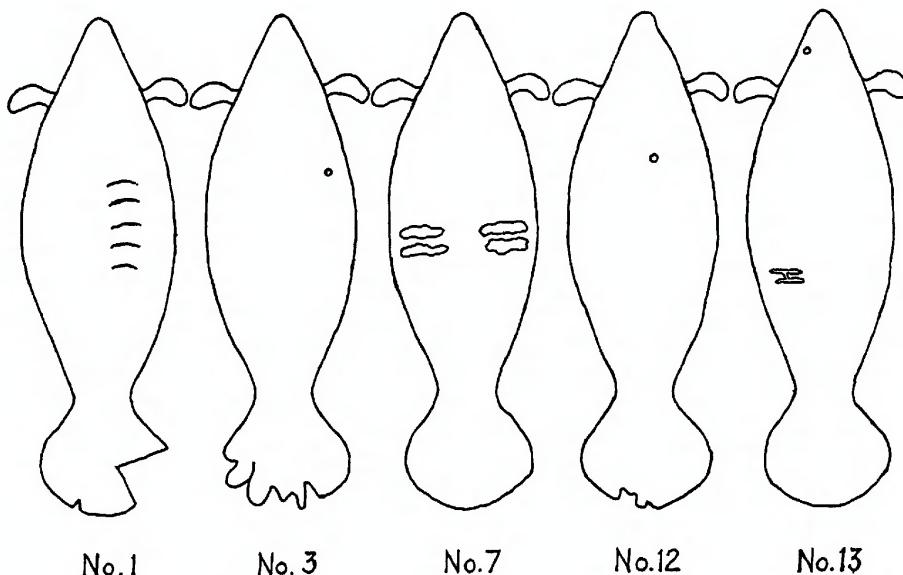


FIG. 1. Identifying marks sketched on stenciled manatee outlines for the individuals known over five-year period.

It was not until the winter season of 1954-1955 that it proved possible again to take time for a good series of observations through a whole winter season. Identification of as many marked individuals as possible during this season was emphasized in order to record enough females that could be repeatedly observed through still another season or more to reveal their rate of reproduction. Departure from Florida before the 1955-1956 season stopped this aspect of the program in mid-career, but

knowledge of manatees is so limited that the observations made constitute the most extensive and detailed ones available on free wild manatees.

NUMBERS

During the first season of observations, that of 1949-1950, the number of permanently identifiable manatees recorded was only seven. At one aggregation the following year four more were added. None were recorded the third season, but one day in the fourth season records of two more were obtained. Observations of two aggregations during the fifth season yielded five more permanently identifiable manatees. The total recognized at the beginning of the sixth season, therefore, was 18. Focus of effort on identifications in the sixth season brought the total number up to 60. Of these 60 marked manatees, 53 were observed at some time in the 1954-1955 season.

There were, of course, many individuals that were unscarred. There were also some that could be distinguished for the day by the amount and arrangement of barnacles and brownish marine growth on them, or the presence of skin blemishes, minor tail notches, or white scrape marks that might be ephemeral. These individuals were regarded as inadequately marked to be added to the list of permanently identifiable ones. Two mothers and their small young were, however, found to be adequately marked by such means and by the fact that the young and parent were

TABLE 1
DATA ON MANATEES OBSERVED IN MIAMI RIVER IN METROPOLITAN MIAMI IN
TEN AGGREGATION DAYS IN THE 1954-1955 SEASON

	December				January				February			March
	4	5	21	22	15	26	30		12	13		30
Hour (a.m.) observa-												
tion began	8:30	8:40	6:50	8:15	8:00	8:00	7:35	9:50	8:30	7:45		
Duration												
(hours and minutes)												
of observations	1:45	1:35	5:00	3:30	4:00	4:00	4:40	3:40	2:30	1:45		
Number of individuals												
that were												
Identified by marks	8	6	14	16	17	18	16	21	28	1		
Estimated present	15	12	48	43	57	60	57	69	65	7		
With calves	1	0	4	3	3	2	5	4	4	1		
Known before	3	3	3	5	4	4	2	6	4	0		
Observed one day only	2	0	2	2	3	1	5	2	5	0		

always observed together, to be identified confidently during the one season, and they may be added for the purposes of this paper to the permanently identifiable ones, increasing the number of marked manatees observed in 1954-1955 to a total of 57.

The ratio of unmarked to marked manatees present in any one aggregation was occasionally estimated. On one occasion, when apparently only seven individuals were present, the ratio was six to one. Some days, on the other hand, the ratio seemed to be as low as one to one. The estimate on several days was two to one, and this seems to me (then as now) to be a conservative season average. On this basis we may assume that the number of individual manatees that congregated below the Miami Avenue bridge on one or more of the 10 observation days during the winter of 1954-1955 approximated 171. Since eight of the 57 marked manatees had unmarked calves with them, this swells the season number that it is possible to count to 65, and the estimated total to 195.

While this may be somewhat surprising, it should not be altogether so, because Barbour (1944, p. 99) reported that a naval officer of one of the lighter-than-air craft on the coastal patrol had observed "some thirty manatees in a day while flying over the shallow waters of Bay Biscayne, right near Miami."

NATURE OF AGGREGATIONS

Several authors have reported manatees apparently killed by severe freezes in Florida. William B. Robertson writes¹ me that three dead ones were noted in the Everglades National Park after the severe freeze of January 15, 1956. The present writer has recorded elsewhere (1951b, p. 14) that small numbers of manatees gather in the relatively warm outflow of a giant spring in north Florida during severe cold snaps, and furthermore (1953, p. 121) that large aggregations form during cold snaps in the more tropical waters of the Everglades National Park *where there is no special warming feature evident to attract them*. Figure 2 shows the daily minimum temperatures from the records of the United

¹ Letter of July 12, 1956: "Three sea cows, . . . about half-grown in Barney's opinion, were found dead in the latter part of January. . . . The information is contained in a memorandum from [Park Ranger] Barney Parker to the Superintendent which we have in the observations file. Barney states that he examined all the animals carefully and found no sign of bullet holes or any injury. The localities are as follows: 1. Lostman's River, Big Bay, approx. Lat. 25° 33' N., Long. 81° 05' W. We have the skull and some other skeletal parts of this one. 2. Cabbage Bay, approx. Lat. 25° 38' N., Long. 81° 06' W. 3. Tarpon Bay, approx. Lat. 25° 25' N., Long 80° 59' W. Ernest Borgman, a new ranger in the Cape Sable District found this one, and Barney checked it later."

States Weather Bureau for "Miami W. B. Airport" in relation to the estimated numbers of manatees in each of the observed aggregations of 1954-1955. Six of the seven largest aggregations observed were present mornings after the temperature had been down to 42° F. or lower, and this included six of the seven lowest temperatures of the season. Despite the artificiality of the surroundings of the Miami River aggregation site, and despite the artificial warm-water attraction, it seems proper to regard these Miami Avenue bridge aggregations as essentially natural.

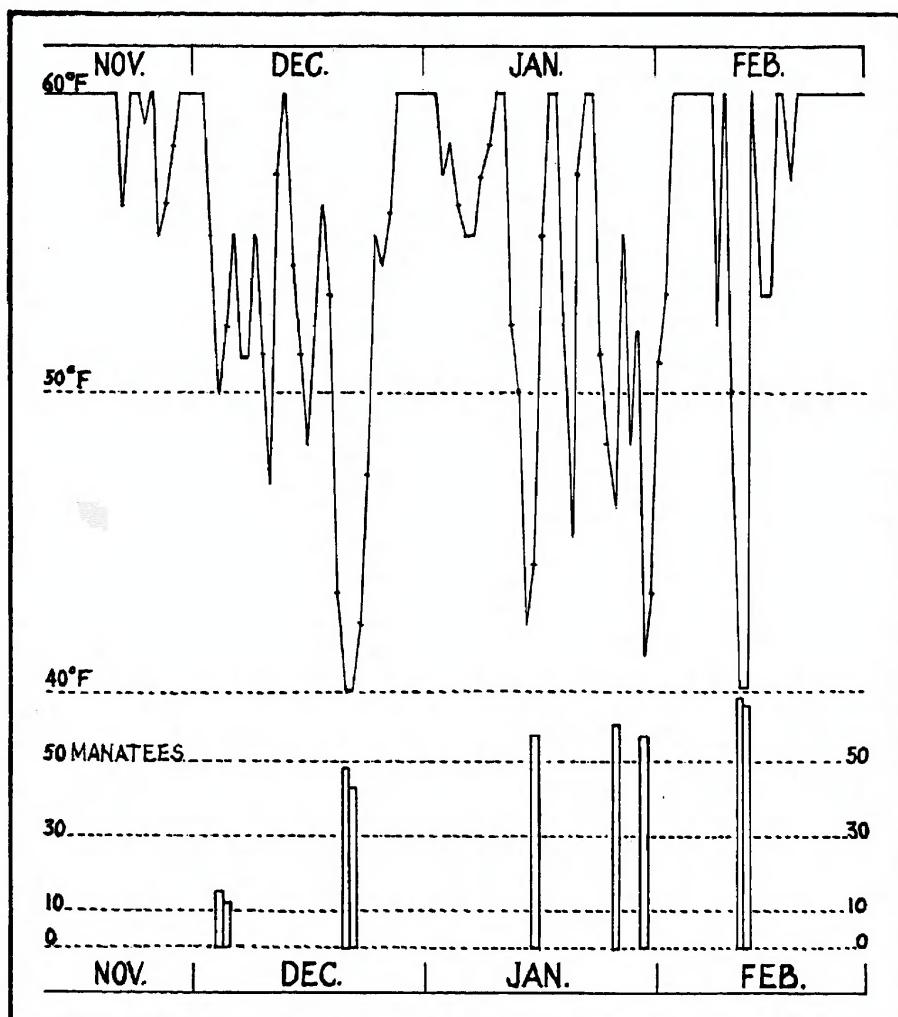


FIG. 2. Observed manatee aggregations in relation to daily minimum temperatures, 1954-1955. (Records of higher than 60° F. are recorded as 60°.)

RESIDENCE

The Miami River and other canals and waterways within the Miami metropolitan area appear to provide natural habitat for manatees. Safford (1919, p. 424) mentions manatees coming into the Miami River to feed on the aquatic vegetation, and saw manatee grass, *Cymodocea manatum*, being fed in quantities to a captive manatee in Miami. David Fairchild (Anonymous, 1917, p. 343) presents a photograph of a man apparently harvesting manatee grass to be fed to a captive. The present writer (1951a, 1951b) presented much evidence of manatee occurrence in the Miami River and other metropolitan Miami waterways. A Florida law protecting manatees was established in 1893 (Bangs, 1895, p. 785), and since May of 1907 they have been safeguarded by a fine of \$500 for a person who kills or molests one (Anonymous, 1917, p. 344). They are of course safest from lawless persons in the metropoltion area, where there are many eyes to see and conservation organizations which would not tolerate public violation of this law.

If the habitat appears suitable, and the general presence of manatees is well established, the next question is, do individual manatees show any evidence of residence here? There is some evidence on this. Five of the seven marked individuals first identified in 1949-1950 were again recognized in 1954-1955. Two of these free, wild sirenians were known by these accurate means, therefore, over a span of five years and 88 days. The best known one was identified in 13 different aggregations during four of the six winter seasons. This and further evidence of the presence of individual manatees during more than one year and apparently for considerable spans of time during some single seasons is presented in table 2.

TABLE 2

NUMBER OF DAYS BETWEEN OBSERVATIONS OF INDIVIDUAL MANATEES, AND
NUMBER OF TIMES (IN PARENTHESSES) OBSERVED EACH WINTER

Identification Number	1949-1950	1950-1951	1951-1952	1952-1953	1953-1954	1954-1955
1	9(3)	—	—	—	0(1)	70(4)
3	9(2)	—	—	—	—	71(5)
12	0(1)	—	—	—	—	70(7)
13	9(2)	0(1)	—	—	73(3)	71(7)
15	—	0(1)	—	—	0(1)	70(6)
18	—	—	—	—	0(1)	69(5)
21	—	—	—	—	73(2)	29(4)

Some individual sea cows showed up in so many of the 1954-1955 aggregations as to indicate that they must have been at least seasonal residents in the vicinity. In addition to seven such individuals recorded in table 2, there are 11 that were identified in three or more of the 1954-1955 aggregations, and that with one exception were evidently present in the vicinity for more than 50 days. It should be interesting to examine and compare the records of attendance of the aggregations by these 18 individuals. (See fig. 3.)

FIG. 3. The 1954-1955 aggregation attendance records of the 18 manatees showing the best evidence of residence, arranged in that order. Solid-line rectangles indicate aggregations attended; dotted-line rectangles, aggregations missed. Dashed lines indicate span of time over which this evidence suggests manatees were resident in vicinity.

My own field experience and that of others cited indicate that, except for these cold-snap aggregations, the manatees are at least diurnally deployed in their habitat individually and in small groups. If it is assumed that they are ordinarily thus widely distributed both by day and night, one factor that would differentiate between these sluggish animals in their response to the stimulus to aggregate might be their different distances from the aggregation site. On the basis of the very little that is known

about manatee habits, this matter of distance seems to me the best explanation of the recorded differences between marked individuals in their attendance of the 10 observed aggregations of this one season. Number 40 thus ranged over an area which perhaps centered about the aggregation site, so that he could successfully respond to the aggregation stimulus probably every time that there was one. Numbers 12 and 13 each attended seven aggregations but apparently missed one or two in the middle of the season. This suggests that they ranged close about, but also a little farther away, so that once or twice these individuals were caught by cold snaps too far away for the stimulus to bring them in. Possibly the extent of No. 3's ranging was still more distant, for, while it was evidently present in the general vicinity for at least nine of the aggregations, it attended only five. To carry this progression to its end, the number of manatees that attended only one aggregation is 22, and it is logical that the ranges of this number would be farthest from the aggregation site. Thus it appears that the number of aggregations attended by a manatee may be inversely proportional to the amount of time or energy required to reach the aggregation site from its range. Furthermore, beyond the maximum distance from which the cold stimulus motivates these sirenians to come to the Miami Avenue aggregation site, it seems likely that they may be stimulated to aggregate in other places.

From the information presented one may begin to visualize the manatees distributed widely out through Biscayne Bay and up the Miami River and various canals and other waterways of requisite width and depth. Each manatee may also be conceived to have an independent range, however much it may overlap that of others, and even if several manatees fully share a nearly identical range, and are occasionally seen together, they may be occupying their ranges quite independently. Such a circumstance is suggested by the degree to which the sequence of aggregations attended by any marked manatee differs from that of the others. Consider, for instance, manatees Nos. 13, 40, 3, 37, 1, 39, and 43 in figure 3. The ranges of these seven sea cows are distributed in the Miami River rather than Biscayne Bay, for they were each noted to be clean and black or coated only with a film of green fresh-water algae, whereas inhabitants of the bay were easily distinguished by the coating of reddish brown marine growth and a sprinkling of barnacles which they accumulate in that habitat. Even though some of these seven sea cows were surely neighbors in the river, their attendance of the aggregations show remarkable independence of one another's society. Perhaps the little groups occasionally met with in the rivers and bays of south Florida (Bangs, 1895, p. 785; Krumholz, 1943, p. 272) are more casu-

ally formed and ephemeral than we have earlier assumed. It now seems a much better possibility that at least during the winter season the adult manatees are each individually established in a certain range to which they adhere, and that these ranges are individually distributed through the suitable habitat, however much overlap occurs.

As the aggregations themselves are apparently associated with exceptionally low temperatures, we should not expect to find here much evidence relating to the seasonal migration reported for the Florida east coast (Moore, 1951b, p. 11). However, one cannot help noting that manatee No. 40, which ranged closely enough about the aggregation site to be present for seven consecutive observed aggregations, missed the earlier two and the last. This suggests that it may have moved south to this vicinity in mid-December and departed northward before the end of March. Eight of the other 18 manatees represented in figure 3 were recorded present in aggregations only within these same extreme dates. These records are therefore observed to be in accordance with the earlier reported indications of a northward summer-season displacement of at least part of the population on the eastern coast of Florida.

PLAY

During the early morning, while the sun and air temperature were still low, the sea-cow aggregation seemed very quiet, and few showed more than their snouts at the surface. About an hour after sunrise individuals coming up for a breath began more often to show enough of their bodies at the surface for identification, and more casual drifting about took place in the eddy between the warm current and the north shore. By three hours after sunrise the sun usually warmed the surface of the water, and many manatees lingered at the surface for minutes at a time. More individuals showed an active interest in one another, and there was more general moving about within the crowd. After an hour or so of this the sun began to reach the midday position, and the manatees became less active again. Although some still drifted in the resting position with backs at the surface in the strong sun, the number present began to diminish noticeably, evidently as dispersal took place under water.

There were a number of days during the 1954-1955 season when the aggregations were especially large and when watching during the late morning social hour was particularly rewarding. The manatees, like elongate balloons, effortlessly rose and sank, often in such density that they overlapped one another. A rising one sometimes lifted another's head or tail above the surface, or had to move to one side to get to the surface. When one rose in another's face, the latter usually nuzzled the presented

body surface for a moment in a mildly interested, exploratory manner. No evidence of irritability attributable to this crowding was observed.

During this period some manatees drowsed at the surface, broad back to the sun but head and tail curled down out of sight; most continued to rise and sink, swimming gently or with balloon-like absence of effort, while still others cruised slowly about in the warm current. Some individuals moved independently, and there were groups of any number up to about 10. The more distinct and stable groups were immatures associating in pairs or groups of three or four. It happens that no well-marked individuals were observed to belong to such cliques; hence no data were obtained on whether these lasted for more than the day.

Adults appeared to predominate in the larger mobile groups. Their usually mild movement occasionally intensified into a violent, thumping swirl. While these momentary clashes rarely happened close at hand or when my eye was upon the participants, I came to regard them as being an expression of some emotional release other than that of anger. When most active, these groups ranged an area in the warm current with a long diameter of perhaps 120 meters and only rarely came immediately beneath the observer. Although these may have been groups of males seeking favor of a female, it was never apparent to me that any one individual was being consistently or repeatedly pursued. These groups may indeed have been of unstable composition, picking up and losing individuals as they moved through the crowd, but one persisted for perhaps an hour in several of the larger 1954-1955 aggregations and in several of earlier years.

The smallness of the March 30 aggregation permitted observation of an active group of five manatees over a period long enough to insure identification of the one marked individual and to ascertain that none of the other four had permanent marks. The marked one was an adult, but the other four appeared to be immatures. Staying between 15 and 50 meters from me, they swam up and down in the warm current, nuzzling one another, doing rolling surface dives, and making resounding splashes as much as I have seen manatees do. At times they seemed almost to be wrestling, but I could not determine at that distance whether any of this play was sex inspired.

GREETING

Occasionally two adults lying or rising to breathe side by side turned their heads towards each other and lifted their snouts above the water in a muzzle-to-muzzle kiss. This occurred between sea cows that had just come together, and appears to be a gesture of mutual identification.

(See fig. 4.) It is interesting that, although the contact often began below the surface, it characteristically included the raising of both muzzles above the water. If airborne scent is important in the ritual, it is extremely interesting to find the gesture retained in this formerly terrestrial animal which has become so extremely well adapted to aquatic life that, except for the air it must obtain from above, one may regard the water surface as the virtual ceiling of its world.



FIG. 4. Separation for a moment in the above-water, muzzle-to-muzzle manate greeting. Aggregation of February 13. Photograph by Ralph S. Palmer.

COURTSHIP

Apparently no observations on the courtship of the manatee have previously been published. Quite possibly no naturalist has ever before observed sea-cow courtship in even the following fragmentary detail.

Males and females were indistinguishable as such ordinarily, but during those periods when members of the aggregations were most active at the surface, one occasionally rolled over on its long axis, barrel-like the full 360 degrees. The manatee rolled slowly, and, if it was close

enough to the observer, its sex was easily distinguishable by the proximity of the male genital aperture to the navel and the proximity of the female one to the anus. A number of times one did the barrel roll within 3 or 4 meters of the observer, but only about a third of these times did a rolling one show identifying marks before disappearing below. Consequently of the marked manatees only Nos. 35, 39, and 73 were thus determined to be males and No. 33 a female. Nevertheless, this strengthens the basis for reporting some of the observed activity as courtship behavior.

The identifying marks of one of the most active males, No. 35, happened to be conspicuous and near the back of its head, so that it was often identifiable even when it only exposed its snout at the surface to breathe. In the December 21 aggregation it was almost continuously active during the late morning social period in pressing its attentions upon other adults. In the aggregation of the next day, however, it was observed to do this only about three times. When moving through the surface crowd or rising to breathe, No. 35 came alongside a stationary adult, turned to it and nuzzled its side in an interested fashion, then raised his nearer flipper onto the other's back. Both animals lying horizontally, belly down, gives the viewer above somewhat the impression of two short fat men facing away, one with a stubby arm halfway around the other's back. It does appear less so from the lower camera angle in figure 5. After a second or two in this position, the male slowly rolled until his venter was towards the passive one. With this, the approached one slowly rolled upon its long axis until its venter and genital aperture were turned 180 degrees away from the aggressor. If this did not send the attentive one away, the approached manatee stroked unhurriedly with its tail and moved away. Sometimes No. 35 followed; other times he turned his attention to some other near-by adult. When so rebuffed or left behind on one or two occasions, he did a barrel roll, apparently an example of displacement behavior. This was accomplished quite slowly and with the flippers relaxed flat against the chest. Manatees other than No. 35 were also observed to make this identical approach, receive the very same rebuff, and even sometimes to do the barrel roll. Number 27 persisted in this pursuit until it was presumed, although not proved, to be a male. Once when he had so approached No. 33, and she had so fled his attentions, she did two barrel rolls in succession at the surface near the observer, clearly revealing her sex. Thus in the one case in which the sex of the approached individual was known, it was a female.

Once in the December 22 aggregation an unmarked manatee approached another directly beneath the observer. It nuzzled the other

manatee's side, put up its flipper on the other's back, then rolled until venter was towards the object of its attentions. For once no avoidant move was made. After a pause the aggressor rolled gently venter down and let his flipper slide off into the water. Paddling softly with flippers, he explored with his muzzle along the other manatee's side up about at its midlength, during which time his own body had moved away from the other's to a right angle so that the other's long axis crossed his own like the top of a "T." The male then rolled over on its own long axis until venter up (thus revealing his sex) and in this position carried his nuzzling down the other's side to under its belly and explored with his muzzle along towards its genital area. As this was apparently reaching the passive one arched its back up away slowly but mightily and the



FIG. 5. Adult manatee with the right flipper "embracing" another animal. All of these animals have been inhabiting fresh water, and the sunlight glints on the isolated hairs, revealing their singular spacing. The coating of the skin of the third manatee with brown marine growth shows that it has been inhabiting the salt-water bays. Aggregation of February 13. Photograph by Ralph S. Palmer.

slid over easily into a surface dive. The male then also submerged.

Other individuals were subsequently observed to re-enact this much of the courtship, and again it was virtually identical procedure. In no instance was the genital organ of a male observed to be extruded. Copulation, because of the structure of these animals, must be accomplit-

with the pair in venter to venter position. From the above reported observations it seems likely that the male may initiate the union from beneath, although with more cooperation copulation might take place with both animals lying on their sides at the surface.

REPRODUCTION

The 57 marked manatees recorded in the 1954-1955 aggregations may be sorted out, on the basis of records made at the time, into: (a) 32 adults not accompanied by calves; (b) 10 adults each accompanied by a calf; (c) 10 immatures not accompanying any adult; (d) two calves accompanying adults; and (e) three undescribed but definitely belonging to either the a or c class. Being closely associated constantly with an adult is the only criterion that distinguishes the larger of the calves from the smaller of the "immatures." The immatures were distinguished from the adults arbitrarily by apparently shorter length and more slender form. If the sex ratio in these 42 marked adults were 50/50, it would then appear that only approximately half of the adult females were accompanied by calves. Aside from any mortality, if these 57 manatees plus their eight unmarked calves were an unbiased sample of the population, and the females bear a single young every year, as has been stated without proof in the literature, and if the young stay with the mothers about a year, it would then appear from the relative numbers that the immatures are two-year-olds and that the adults are three-, four-, five-, and six-year-old members of the population. Adult manatees have virtually no serious enemies in Florida other than man and seem rather well protected against even him in the vicinity of Miami by good law enforcement and by their apparent ability to endure extremely severe wounds inflicted by his boat propellers. A low mortality should therefore be anticipated for adults. This would lead us to expect a greater age represented in the sample than that indicated by the above calculation. That greater age very likely is represented is seen in the fact that five of the seven marked manatees noted in the first season of observations were again recorded present five years later. If the females breed only every other year and the young stay with the mother nearly two years and reach full size after four, the reproduction in the observed sample of 65 animals would then be only five per year. On the basis of the assumptions made, this seems to conform better to the data on the sample observed.

The 10 calves range evenly in size from rather new ones estimated to be 4 feet or less in length to ones estimated to be fully 6 feet long. Their wide and evenly distributed range of size suggests the lack of a distinct breeding season. The three birth dates now known for captive Florida

manatees span nearly half of the calendar year: May 23, August 18, and November 1 (Moore, 1951a, p. 26, and in press). Young estimated to be about 4 feet or less in length have been previously reported for nearly every month of the year (Moore, 1951a, p. 27; 1953, p. 121). Including the birth dates these are distributed with remarkable regularity through the calendar year. By the month, beginning with January, they are: 1, 2, 1, 2, 1, 2, 1, 1, 2, 1, 2, 0.

The number of calves recorded in each of the manatee aggregations of the 1954-1955 season is shown in table 1. No marked manatee was observed calfless and then later with a new calf. Very young calves were, however, occasionally observed with unmarked adults. Babies less than 4 feet in length were recorded regularly with adults No. 37 and 60 over the span of 54 days shown in figure 3. The clean black skins of No. 37 and her calf revealed their occupation of fresh-water habitat, perhaps up the Miami River, but the brownish marine growth and marking with barnacles on the skin of No. 60 and her calf indicated that they inhabited the salt-water bay area into which the Miami River empties a quarter mile from the aggregation site.

BEHAVIOR OF YOUNG

Neither notes nor memory reveals any instance in which another individual persistently accompanied a mother and baby even for so much as one morning in such a way that it might have been construed to be the male parent or the baby's older sibling. Any such associations, which might in fact have existed, could presumably dissolve for the time being in such aggregations. The actual occurrence of any such familial groupings is, of course, presumptuous and unproved in the existing literature. As stated above under the heading Residence the small groups encountered occasionally in the field may be more ephemeral than authors have been disposed to presume.

A young calf ordinarily kept fairly close station with its parent, if the adult were disposed to keep moving even slowly through the throng. Sometimes, however, the adult was apparently still for a time, perhaps sleeping near the bottom and only rising to breathe at considerable intervals. The baby was then seen bobbing to the surface for air at a certain place about every minute, and the observer was hard put to identify its parent. There are three such instances in my notes. Twice it was No. 37, and once the two evidently moved away under water before the adult ever showed itself at the surface where the young one had been rising. More often the parent kept nearer the surface with the baby and even appeared to breathe more frequently than ordinarily in order to accom-

pany the baby closely. Even if other adults crowded in closely, the calf's parent was usually distinguishable because it shared with its young the color and quantity of marine growth on the skin.

The deportment of a mother and baby in the aggregation seemed confident and well adjusted, but their gentle movement, whether proceeding through or drifting with the others of the crowd, was independent of other individuals. One young calf when observed left its mother's side, gregariously approaching other adults and nuzzling their great sides curiously wherever it came into contact with them. When it chanced to approach an adult's head end, the adult turned its face to meet the calf in a muzzle-to-muzzle kiss. This attention was the most bestowed upon it by adults, however, and the calf moved on from one to another of the placid adults, sometimes 12 or 14 feet from its parent, but not placing other adults between itself and the parent. Especially interesting was one gesture that the baby occasionally made when coming alongside the great body of an adult. It stopped and put its tiny flipper up, extended full length onto the broad back as if attempting a companionable embrace. Then after a pause, it withdrew its flipper and paddled on.

It was noticed that the youngest calves swam entirely with their flippers, rising to the surface on a steep angle by rapid, alternating strokes, but most often sinking back out of sight tail first without motion. A manatee baby recently born in captivity (Moore, in press) was reported by its keeper to have swum only with its flippers for some days after its birth. Only gradually and awkwardly did it learn to swim with its tail. This recalls that the Miami Aquarium baby of 1930 (Barbour, 1937) was reported to have been born with its tail folded forward against its venter so that it did not unfold for four or five hours after birth. In a paper read before the Florida Academy of Sciences in 1953 on his observations of manatees, Roswell Bushnell, III, reported handling a wild baby manatee which was so young that its raw umbilicus still protruded, and he emphasized that this baby swam only with its flippers. These observations of infant manatees swimming all appear to be in agreement that the newborn manatee is not ready to swim with its tail. In this respect it appears to be less precocious than the newborn of the bottlenosed dolphin, *Tursiops truncatus*, which can keep up with adults at a good speed, swimming with its tail within a few minutes after birth (McBride and Kritzler, 1951, p. 257).

It is remarked more than once in the literature that the density of the bones of the manatee rob it of buoyancy so that it naturally rests on the bottom when not swimming. Observing two young manatees (apparently *T. inunguis*) in a small aquarium tank, Crane (1881, p. 458) noted that,

unlike the porpoise (*Phocaena?*) which floated to the surface upon ceasing to propel itself, the manatees seemed to repose naturally on the bottom. It is true that the manatees may more often than not repose at the bottom, even in their natural habitat, but it should be evident from the description here under the heading Play that manatees do also repose floating motionless at the surface. It should be pointed out, further, that not only the adults but also the very small young attain so fine an adjustment in this matter that in deep, still water they sometimes repose, motionlessly maintaining a position about 18 inches or 2 feet beneath the surface of the water. McBride and Hebb (1948, p. 113) reported the ability of the bottlenosed dolphin, *Tursiops truncatus*, to remain stationary about a foot beneath the surface for half-minute periods while sleeping. It seems worth noting the nice control evident each time a mother and its young were observed to submerge while engaged in suckling. There was no indication of the young one's being drawn down by the mother; they sank without the slightest alteration of relative positions, in what seemed to be perfect coordination, and without movement of tail or flipper.

Twice one morning I saw an adult come up accidentally under her baby, lifting it as she rose. The baby, appearing to sense that it was about to be lifted into the air where it could fall, flattened itself out and spread its flippers as far as it could reach as if to keep from falling off. Each time the adult ceased to rise before it lifted the calf out of water. Another morning a marked adult manatee came up into sight close at hand three different times with a 5-foot calf riding on its back. The young one was situated rather far back where the broad back tapered enough for the calf to be able to clasp it somewhat with its short flippers. Once when the adult rose buoyantly towards the surface, and threatened its rider with being exposed above the surface, the young one scuttled backward down its parent's bowed back. One of the Florida manatees born in captivity, the 1955 one, was reported to ride occasionally on its mother's back, being lifted partially out of the water at times. Probably this back riding is a not infrequent habit.

One might expect to have observed something that could be called play in so many observations of manatee calves. I saw nothing that impressed me as such. The social exploration described above could conceivably be classified as play but seemed to me rather serious and purposeful. The riding on the mother's back could be play, but it may just be a way to rest. There seems almost to be an absence of play by calves in the aggregations, which is where one might suppose the stimulus to play to be greatest. Mothers with small young often came together in

the aggregations, but the calves seemed to hold no special attraction for one another. Beebe (1921, p. 234), observing a young calf swimming about its mother at Georgetown, British Guiana, put it aptly, ". . . the young one played about, slowly and deliberately, without frisk or gambol, but determinedly, intently."

SUCKLING POSTURE

There has been a powerful tendency in popular literature to cling to a legendary allegation that a mother manatee holds her baby embraced in a flipper while it suckles at the breast with its little head held above the water so that it can breathe during the process. A pose so like that of a woman nursing her baby has popular appeal, and, because scientific observation until now has neither confirmed nor denied that manatees do this, the very age and persistence of the legend may seem to have enhanced its legitimacy.

On January 7, 1951, at about 10 A.M. the present writer observed an adult sea cow suckling its small young in the Miami River. This was during an aggregation below the Miami Avenue bridge, but the two were alone in clear, still water between the bows of two vessels moored side by side at the north bank of the river, where the writer could see them easily at a distance of about 10 meters. The adult's back was exposed at the surface, but her head remained under water except when she raised it momentarily for a breath. She lay horizontally in the water, venter down, with her right flipper extended laterally and forward. The calf also lay venter down, with its back partly exposed at the surface, and its body at an angle of about 70 degrees to that of the adult. The young one's snout protruded above her flipper where it sucked the teat in its axil, but was several inches under water. They were in view for about 45 seconds before they sank out of sight, without changing posture.

Again at the same place on December 21, 1954, another mother sea cow and small calf were observed suckling in just the same relative positions and relationship to the water surface, but were in sight only about four seconds before sinking out of sight, still suckling. Again the only postural contribution that the adult made to the suckling procedure was that of holding its flipper out of the calf's way. About 8:30 the following morning at the same place, another observation was obtained of a mother suckling its quite young calf. Their relative positions were exactly the same as those reported for the preceding two observations. When first observed the animals were several inches under water and sank down out of sight after about four seconds without changing posture. These latter two observations were made at a distance of about 4 meters.

On January 26, 1955, at the same place, the writer observed an enormous old sea cow suckle a 6-foot calf under water in the same relative positions. This was observed only fleetingly, but the posture relationships were certainly identical. This large calf was with her regularly in both of the aggregations in which she was observed. My notes do not indicate which, but in one of these four observations of suckling I recall observing the lips of the young one to move in a faint but rhythmic sucking motion.

Observations of the suckling of the baby manatee born at Theater of the Sea was summarized by Mrs. Prescott as follows, "Neither cow nor calf surfaced while nursing. The cow either lay quietly on the bottom or fed from place to place over the bottom of the pool while the calf nursed. When lying on the bottom, the cow turned slightly on one side, and the calf came in under the flipper where it meets the body, the teat being located there" (Moore, 1951a, p. 27). In the case of the one recently born captive at Tropical Panorama, its keeper informed the writer (in press) that the mother merely lay horizontally in the water, venter down, feeding or drowsing while the baby helped itself to a teat under water from either side as best it could.

The four observations of the suckling behavior of at least three combinations of mother and young manatees in a free, wild, undisturbed state, and the more extensive, if second-hand, observations of the suckling habits of two more mothers with babies in captivity contribute a common pattern which differs with the legendary one in several respects. The young manatee is not clasped, neither animal's head is held above water, and neither animal is in a vertical position. Further than misrepresenting the facts of the posture of nursing, the legendary picture misrepresents its spirit as one displaying parental protective concern for an altricial young, whereas in fact its postural attitude is extremely casual and lacking in appearance of concern for its really quite precocial young.

LOCOMOTION

The above-mentioned exclusive use of the flippers by new baby manatees for swimming is, of course, exceptional to A. B. Howell's (1943, pp. 208, 229) conclusions regarding the limbs of the manatee in his comparative anatomical study of marine mammals. He finds that ". . . the osteology of the dugong does render it possible that at some comparatively recent time its flippers could have been used for propulsion in quite efficient fashion . . ." but that ". . . the anatomical details of the manati indicate that this animal has never used the pectoral limb as a means of propulsion through the water since this member became

specialized." My field observations of the swimming of adults in general support Howell's analysis, but even in adult swimming there was one exception.

This exception was provided by an especially large manatee, presumably a female because a 6-foot calf followed it closely at all times, and she was present in the aggregations of January 26 and 30. She seemed always very restless, quite unlike the other manatees, and swam doggedly back and forth and around through the aggregation. My field notes written there on the latter date record that, unlike other adults, she could be seen using her flippers to swim nearly every time that she came up to the surface and that, even when seen out in the current swimming strongly against it for some distance, she used her flippers steadily as well as her tail. She was alternating right and left flippers in an antero-posterior stroke. Howell might not have regarded this stroke as a "quite efficient fashion" such as he meant for the dugong, for he may have been thinking of the high-speed flying stroke of the sea lions rather than any kind of antero-posterior stroke. However, he put no such qualification on his above-quoted conclusion about the manatee; hence this one adult which swam with its flippers seems as valid an exception to Howell's thesis as my general observations are support of it.

Perhaps it should be mentioned that the adult manatees in the aggregations were observed frequently to use their flippers skillfully to scull themselves slowly about to the right or left. In his study of their anatomy Howell (1930, p. 247) concluded that in action the flippers would be "waved about as assistants to the accomplishment of a variety of rather languid evolutions." I have observed that captives in the confinement of small aquarium tanks do virtually all of their languid moving about while feeding, entirely with the flippers, and go forward, to either side, or backward with about equal facility. This brings to mind Gaumer's (1917, p. 29) statement that when a manatee is surprised while feeding on the bank of a river with only the posterior half of its body remaining in the shallow water, it backs into the water by means of violent strokes of the tail and disappears with dispatch. He adds that he has seen them leave such a position head first, but more slowly. Gaumer also tells (p. 30) of a manatee that took refuge from him in a subsurface cavern from which flowed an underground river. He remained silently watching the mouth of the cave, and when the manatee emerged head foremost at the bottom of the clear water, it saw him and backed into the cave again. A manatee backing by means of the tail is something that I have not seen.

Under the subject of locomotion one almost hesitates to mention that manatees appear to be quite powerless to make any forward progress

when stranded completely out of water. Howell (1930, p. 247) says, "As these mammals are entirely helpless out of water there is not the need for abduction to 90 degrees of the wrist that the sea-lion has." It may be worth mentioning that the captive adult that the present writer observed attempting to progress when stranded, knuckled its flippers under, or adducted rather than abducted them. A photograph in Hayman (1955–1956, p. 99) shows a stranded manatee with its flipper in the observed position, and, furthermore, he comments on the same page, apparently in reference to observations of two captives from British Guiana, "In shallow water a manatee will walk on the inturned tips of the flippers."

Crane (1881, p. 460), Garrod (1877, p. 139), Brown (1878, p. 295), and the present writer (in press) observed captives and concluded that they could not progress on land. Roswell Bushnell, III, whose observations of captive manatees have far exceeded mine, writes (letter of February 28, 1956), "I have seen the male attempt to move along when stranded. . . . I am of the opinion that a full-grown manatee is totally incapable of locomotion when completely stranded."

SUMMARY

The difficulties of observing wild manatees under ordinary circumstances were found to be substantial and were considered to explain the absence of any previous report of systematized field observations. Natural cold-induced aggregations of wild manatees were found to provide favorable circumstances for field observations. Identification of individuals by means of scars permitted recognition of some of them five and a quarter years after first identification. During the last winter season of observations, 1954–1955, in 10 aggregations, 57 marked individuals were recognized and 195 individuals were estimated to have been present. Some of these evidently reside in the vicinity at least during the winter season. And of these some appear to move in for the winter season, possibly taking part in a seasonal migration. Presence or absence of barnacles and algae on the skin indicates that some individuals reside in fresh water up river, others in the saline waters of the bay. Pattern of attendance of aggregations by marked individuals suggests that their ranges were dispersed and reveals no evidence of social organization. Mothers with young were not accompanied by other individuals. Groups within the aggregations engaged in play. The muzzle-to-muzzle contact between individuals involves lifting snouts above the surface, perhaps as relict behavior inherited from terrestrial ancestors. The usually observed courtship behavior was of a male approaching, nuzzling, "embracing," and presenting its venter to some presumed female, which most frequently

turned away or swam off before courtship proceeded further. Of the identifiable sample of 65 individuals about 15 per cent were recorded as immatures and 15 per cent as calves, each closely accompanying an adult. The relative sizes of calves and other evidence suggest lack of any distinct breeding season. Annual reproduction by adult females is questioned. Young sometimes rode on mother's back. Suckling took place in horizontal position, under water, without embrace. Very young calves swam only with flippers. Adults ordinarily swam only with tail, but one adult regularly used its flippers also.

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